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Early adopters and their motives: Differences between earlier and later adopters of residential solar photovoltaics

A. Palm

Department of Technology Management and Economics, Chalmers University of Technology, 412 96, Göteborg, Sweden

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ABSTRACT

To facilitate and forecast the diffusion of sustainable innovations, such as solar photovoltaics (PV), it is important to understand what motivates people to adopt them. Early adopters are known to be partly driven by other motives than late adopters, and adoption motives may thus change over time as new user segments gain interest in the technology. This paper investigates differences in adoption motives between the earliest and somewhat later adopters of residential PV systems. First, a systematic literature review is conducted, in which the findings of previous studies are mapped against the market maturity of their empirical contexts. The review reveals that the earliest PV adopters are driven mainly by environmental concern and technophilia, while later adopters are driven predominantly by economic gains. Second, an empirical investigation of Swedish adopters over a nine-year period is conducted, using Green Party voting as a proxy for environmental concern. It is found that the relationship between Green Party voting and PV adoption weakens over time, again suggesting that the earliest adopters are more driven by non-financial motives such as environmental concern than later adopters. The results can inform diffusion forecasting as well as marketing and information campaigning intended to induce PV adoptions.

1. Introduction

To mitigate climate change, it is important to understand current and future diffusion patterns of renewable energy technologies, such as solar photovoltaics (PV). Knowledge on how different factors influence diffusion can facilitate the design of policy instruments and marketing intended to increase adoption rates, and help researchers and authorities forecast future diffusion. Not least, it is important to understand the motives that different actors might have for adopting – i.e. acquiring and start using – a new technology, and how these motives develop over time as the market matures and new user segments start adopting the technology. In other words, it is desirable to grasp what differs earlier adopters from later ones.

Research on the diffusion of innovations goes back several decades [1]. A common objective of this literature has been to shed light on what distinguishes the earliest adopters (in terms of e.g. motives or personality traits) from later or non-adopters [e.g.2]. Yet, the understanding of these dynamics remains limited, with evidence being weak for many of the most cited predictors of early adoption [1].

The purpose of this paper is to investigate how adoption motives differ between earlier and later adopters of residential solar PV systems. Solar PV is a promising renewable energy technology that is suitable for both large- and small-scale applications [3]. The market for residential PV systems – i.e., PV systems adopted by households, typically as rooftop installations – has grown rapidly around the world in recent years, although this market growth has been unevenly distributed between countries [3]. Hereafter, "PV" will refer to residential PV systems if not otherwise stated. Existing studies of PV adoption motives tend to provide snapshots of motives from different contexts, while the understanding of shifts in motives over time, as PV markets develop, is limited. To facilitate and forecast PV diffusion in immature as well as more mature markets, it is useful to understand adoption motives of the earliest as well as later PV adopters. For example, public information campaigns and marketing efforts that are purposeful in an immature market may need adjustment to appeal to later adopters.

The paper employs a systematic literature review and an empirical investigation of Swedish PV adopters over a nine-year period. The systematic review maps findings regarding PV adoption motives against the level of market maturity of the studies' empirical contexts, thus revealing general patterns of differences in motives between earlier and later adopters. The empirical study employs a – for this research area – novel approach to investigate how a non-financial adoption motive – namely environmental concern (measured though a proxy variable) –

E-mail address: alvar.palm@chalmers.se.

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List of abbreviations

IEA	International Energy Agency
GHI	Global horizontal irradiance
kW	Kilowatt
m	Meter
MW	Megawatt
MWh	Megawatt hour
PV	(Solar) photovoltaics
SEK	Swedish kronor
UK	United Kingdom
US	United States (of America)
USD	United States dollar

has developed over time in Sweden. More specifically, it uses regression analysis to investigate the relationship between Green Party voting and PV adoption over time (this approach is justified in section 4). The empirical research, using fundamentally different data and methodology from previous research, corroborates the review's results through triangulation.

The rest of the paper is structured as follows. In the next section, an overview of concepts and findings of previous literature is provided, covering the following topics: differences between earlier and later adopters of innovations in general; factors known to affect PV adoption rates; and differences between earlier and later PV adopters. In section 3, a more systematised and delimited literature review is performed, in which PV adoption motives and local market maturity are mapped and compared to identify differences between earlier and later PV adopters. In section 4, the research design of the empirical study is presented, while the empirical results are presented in section 5. Conclusion and discussion are provided in section 6.

2. Frame of reference

This section provides an overview of concepts and findings of previous literature related to early adoption of innovations and to PV diffusion. This broad review contrasts to a more delimited and systematised review, mapping PV adoption motives against local market maturity, which is presented in the subsequent section.

2.1. The earliest adopters of new technology: their characteristics and what motivates them

Research on what distinguishes earlier adopters from later ones goes back to the first half of the 20th century. The most well-known work on this topic is Rogers seminal book *Diffusion of innovations* [2; first issued in 1962] in which (among several other contributions related to innovation diffusion) adopters were divided into idealised categories depending on how early they are to adopt new innovations in relation to other people in their social system. Rogers presented a set of personality traits and other characteristics that proposedly distinguished earlier adopters from later ones. He referred to the very earliest adopters as *innovators*, whom he considered to constitute about 2.5% of all potential adopters. Somewhat later to adopt were, in this framework, the *early adopters*, constituting about 14% of all potential adopters, after which, in the following order, the *early majority*, *late majority,* and *laggards* adopt the technology. According to Rogers, innovators tend to be venturesome and eager to try new ideas, and to maintain cosmopolite rather than local social relationships. Across all adopter categories, Rogers described earlier adopters as more intelligent, more accepting towards change, and more able to cope with uncertainty and risk, among various other characteristics.

As PV diffusion is still in an early stage around the world [3], existing PV adopters are, using Rogers' terminology, dominated by innovators in most markets. In the present study, however, existing adopters will also be referred to as 'earlier' versus 'later' adopters to reflect the possibility of a gradual shift in their characteristics rather than discrete categories. 'Earlier' and 'later' adopters are, thus, used as relative terms that do not necessarily follow Rogers' categories. As the present paper mainly studies innovators, 'earlier' adopters will – when this paper's results and data are discussed – refer mainly to early innovators, while 'later' adopters will include late innovators and subsequent adopters. When discussing other studies or innovation diffusion at large, however, 'earlier' and 'later' adopters – being relative terms – might correspond to other adopter categories depending on the context discussed.

The general validity of Rogers framework has, nevertheless, been disputed [e.g. 1]. Rogers' work is largely empirically based on adoption of farming equipment in the rural US, and it is unclear to what extent it generalises to other technologies and contexts. Alternative frameworks have been proposed, for example by Bass [4] who classified adopters not depending on their timing of adoption but on their degree of social influence versus imitation. Bass terms those who adopt independently of others in their social system as 'innovators' and those who are influenced by their peers as 'imitators'. Rogers' framework is, nevertheless, by far the most established one [e.g.5] and the present paper will employ his terminology.

More recently, various empirical studies have investigated predictors of early adoption. Dedehayir et al. [1], performing an extensive literature review, conclude that the characteristics of innovators and early adopters vary by product category and context. Dedehayir et al. conclude that the empirical evidence for many of the most cited variables is weak, stating that "some of the widely held notions about innovators and early adopters of innovations are not confirmed". More specifically, they find that sociodemographic variables such as age, education and gender show inconsistency, while the more consistent predictors of early adoption include technophilia, previous early adoption of other technologies, and access to resources such as knowledge, technical skills, experience, and networks [1]. Among economic variables, the review of Dedehayir et al. [1] reveals that high income as well as an orientation towards obtaining profits and savings tend to predict early adoption.

The present study investigates environmental concern as an adoption motive. Environmental concern has been found to drive early adoption in studies of technologies related to farming, transportation, food, and energy [e.g.6–13]. However, most of these studies do not compare earlier adopters to later ones, but rather rely on studying innovators or early adopters in isolation, or on comparing them to non-adopters (assuming that these represent later adopters). Thus, it remains unclear whether environmental concern is less important for later adopters of these technologies. The present study, in contrast, studies actual adopters – both earlier and later ones – to identify differences between them.

2.2. Factors driving residential solar PV diffusion

Various qualitative and quantitative studies have investigated factors affecting the diffusion of residential PV systems. Among the most reliable predictors of adoption are factors related to economic gains, such as solar insolation, subsidies, PV system prices, electricity prices, and electricity consumption [14–22]. For example, Jacksohn et al. [18], using household-level data on sociodemographic factors, housing, environmental concern, personality traits, and economic factors, found that German adopters were primarily driven by economic factors. Alipour et al. [14], performing a systematic literature review, conclude that social variables such as gender, political affiliation, age, population density, and race/ethnicity are often poor predictors of PV adoption. On the other hand, education level tends to correlate with PV adoption [14]. Attitudes and values also matter, for example regarding government policy, environmental issues, energy autonomy, novelty seeking, and different aspects of PV technology [14].

Predictors related to the built environment have been found important. In particular, the share of detached homes, the size of homes and households, housing/population density, home ownership, and home value tend to correlate with PV adoption [14,22,23]. Graziano and Gillingham [23] found that built environment variables were more important than "socioeconomic, demographic and political affiliation variables". They also found that PV diffusion occurs through a wave-like, centrifugal pattern emanating from smaller and midsized population centres rather than larger urban areas. Whether a household is located in an urban or rural region is, however, a poor predictor [14].

Income tends to correlate with PV adoption, although some studies point in the opposite direction [14]. While studies using highly aggregated data (mean or median income of large numbers of households) have resulted in ambiguous findings [e.g.24,25], studies using more fine-grained data including total wealth (rather than income only) [26], or household-level data [18], reveal that financially stronger households are more likely to adopt PV. De Groote et al. [22] found that the effect of average income disappeared once variables for home ownership and household size were added. Furthermore, they found that income dispersion increased PV adoptions, which they attribute to adoptions mainly occurring in the upper tail of the income distribution. Third-party ownership business models can facilitate PV adoption among less affluent households, thus reaching new customer segments [27,28].

Information availability has been found to be important for PV adoption. Important information channels, through which homeowners learn about PV, are governments, NGOs, suppliers, peers and media [14]. Information campaigns orchestrated by public entities have been found to substantially increase PV adoption [29,30]. Case studies suggest that local actors can induce PV adoptions through various informational activities [31–33]. Knowledge about financial and technical aspects of PV are useful predictors of adoption [14].

Peer effects are an important driver of PV diffusion as existing adopters influence others (e.g. neighbours and friends) to adopt [14,23,34,35]. The earliest PV adopters often have a desire to prove the concept and inform others about the benefits of PV [36–39]. Research suggests that peer effects in PV diffusion operate more through word-of-mouth than passive observation, and that prospective adopters experience reduced uncertainties when talking to trusted PV owners [40].

Voting behaviour has shown mixed results as a predictor of PV adoption. Democrat voters in the US have been found to be about as likely to adopt PV as Republican voters, while people voting in US general elections are substantially more likely to adopt PV than non-voters [41]. Drury et al. [27] found that voting for a Californian proposition to reduce carbon emissions was a poor predictor of PV adoption. Support for political 'Green Parties' has shown inconsistent results in predicting PV adoption; while van der Kam et al. [25] found Green Party voting to be a significant predictor, other studies have found no or ambiguous effects [20,42,43]. The inconsistency of Green Party voting as a predictor of PV adoption is perhaps not too surprising; Green Parties and political landscapes and discourses differ between contexts. Thus, Green Party voting may arguably show different effects in different contexts even if environmental concern has a more consistent (albeit unobserved) effect.

Studies have also investigated correlations between PV adoption and other sustainable behaviour. The adoption of electric and hybrid vehicles has proven a strong predictor of PV adoption [21,34,44]. However, as PV ownership makes the adoption of such vehicles more profitable for households [45], this relationship might be driven more by economic gains than environmental concern. Participation in a green power scheme has shown some predictive value [16], while recycling behaviour has been found insignificant [42].

Interview and survey studies have found that environmental concern, economic gains, and technophilia are common adoption motives as stated by adopters themselves [e.g.36,37,46,47]. Technophilia among PV adopters is, according to this research, not necessarily general, but often limited to domestic energy technology or similar [37]. A related motive is to demonstrate the technology's viability [36–38]. Energy independence is another common self-stated motive [39,47–49]. Although environmental concern is often important, even the most environmentally concerned PV adopters tend to concede that other motives were necessary for them to adopt as well – that is, environmental concern is necessary but not sufficient for them [37,50,51].

However, the validity of research relying on self-stated motives is jeopardized by potential social desirability bias [cf.52]. Indeed, indications have been found that interviewees and respondents tend to overstate altruistic motives over e.g. financial ones [53,54]. This research also remains inconclusive regarding the relative importance of motives – while some studies have found environmental concern or technophilia to be most important [e.g. 36,37], other studies have found other motives – mainly economic gains – to be more important [e.g. 55,56]. As will be demonstrated in section 3 of the present paper, this apparent inconclusiveness is largely due to different studies studying adopters in markets of different levels of maturity. Once taking the earliness of adopters into account, a pattern emerges in which the earliest adopters tend to stress environmental motives, while later adopters stress economic gains.

2.3. Previous research on differences between earlier and later residential PV adopters

Little research exists on what characteristics differ between earlier and later PV adopters. Below, previous research on this topic is accounted for. Most of these studies have other main foci than differences between earlier and later adopters, and their findings on this topic are thus rather succinct. In this subsection, only studies of actual adopters, or people presumed to adopt soon, are considered, meaning that the studied adopters (also the ones referred to as 'later') are all relatively early in a broader perspective (even later adopters have not been empirically studied as they do not yet exist).

Sigrin et al. [57] used a survey to study changes in PV adoption motives over time in California. They found that motives shifted gradually between 2007 and 2013, from environmental concern and economic gains being of relatively equal importance in the beginning of the period, to economic gains being substantially more important by the end of the period. Furthermore, they found that later adopters had more centrist beliefs on social, political, and economic matters, and were less educated than earlier adopters (although these differences were relatively small). While earlier adopters more often identified themselves as politically liberal than conservative, the opposite was true for the later adopters [57].

Palm [46] compared two sets of interviews performed with Swedish PV adopters in 2008–2009 and 2014–2016, respectively. She found that "there had been a shift in households' reasons for investing in PV" as households in the first interview set were driven mainly by environmental motives and technophilia, while later adopters mainly referred to economic motives. Simpson and Clifton [55], using a survey, found that technophilia was a stronger adoption motive among earlier than later Australian PV adopters. Similarly, Rai et al. [47] found evidence that PV adopters who were first in their neighbourhood to adopt PV were more likely to report technophilic motives, while later adopters more often reported economic motives.

De Groote et al. [22] studied two time periods with different subsidy levels in Belgium. During the later period, reduced subsidies implied that PV adoption was economically less beneficial than in the earlier period even though PV prices had decreased. Overall, their results were "relatively robust over time", although high education and income were only important among the earlier adopters, which is in line with Rogers' framework. However, the ability of respondents to answer whether their roof was insulated was larger during the later period. This variable was used by the authors as a proxy for environmental awareness, although it could, according to the author of the present paper, also indicate a general interest in technical details of one's home. These results suggest that when the economic prospects of adoption are suddenly impaired, new adopters can, on some dimensions, show the characteristics of earlier adopters although they are in fact chronologically later to adopt.

Reeves et al. [58] investigated differences in information preferences between earlier and later PV adopters by comparing survey responses in one young and one more developed PV market in western US. They found that earlier adopters tended to prefer more cosmopolitan information channels (e.g. mass media) than later adopters, which they conclude is in line with Rogers' framework. However, they found no differences regarding neighbourhood-related variables, such as local peer effects.

Shirai et al. [59][1] used a survey to study Japanese PV adopters' tendencies to talk about environmental issues with their friends and family. They divided adopters into three cohorts depending on their time of adoption, finding that earlier adopters had larger tendencies to engage in such conversations.

Mildenberger et al. [41] investigated whether earlier PV adopters (in relation to later adopters in their census tract) in the US were more often registered as Democrats or Republicans, and whether they were more likely to vote in general elections. They found no such differences.

Haas et al. [38] used a survey to investigate differences in motives between Austrian adopters and non-adopters *assumed* likely to adopt relatively soon. They found that the two groups scored similarly in environmental and overall financial motives, but that that the actual adopters were more driven by the motive of demonstrating that the technology works than the assumed next adopters.

To summarise, the understanding of what distinguishes earlier PV adopters from later ones is limited. While most of the existing research suggests that the earliest PV adopters are more driven by environmental concern and technophilia than somewhat later adopters, who are more driven by economic gains, more research is needed to solidify and expand this knowledge. In particular, research relying on other data than self-stated motives is needed to triangulate the existing evidence. The present study addresses this gap.

3. PV adoption motives and local market maturity: A systematic review

As stated in the previous section, existing literature on differences between earlier and later PV adopters is scarce. However, several studies have investigated PV adoption motives without necessarily addressing differences between earlier and later adopters. In this section, a systematic review of this literature is carried out. For each reviewed study, two pieces of information are obtained (se sections 3.1.2 and 3.1.3 for details on how this was achieved):

1. The adoption motive(s) found most important
2. The *market maturity*, defined as the cumulatively installed distributed PV capacity (watts per capita) in the studied empirical setting (this information is used to represent the earliness of adopters)

The reviewed studies are then compared on these parameters, allowing for differences between earlier and later PV adopters to emerge. Importantly, this approach allows for the identification of such differences by combining studies that do not, taken by themselves, say anything about *differences* between adopters. The results of the review are, beyond providing a novel contribution in itself, used to formulate a hypothesis that is tested in the subsequent empirical sections, allowing for triangulation between the review and the empirical research.

[1] Shirai et al. [59] is not available in English, but in Japanese only. To take part of their results, the author of the present paper relied on Google Translate and an account of their study found in Yamamoto [60].

3.1. Approach for selecting and analysing literature

3.1.1. Selection of studies

The review was limited to studies of self-stated motives for adopting PV. All included studies contain an assessment of which motives were most important. The review includes survey and interview studies from different geographical and temporal contexts. Studies using proxy variables were not included as they, due to disparities in data types and methods between the studies, were found infeasible to compare. For example, proxies for environmental concern included pro-environmental voting, recycling behaviour, and adoption of environmentally friendly vehicles. Even studies relying on similar proxies, such as Green Party voting, are difficult to compare between contexts; different Green Parties may have different characteristics, and overall political landscapes and discourses differ between countries. In contrast, studies using self-stated motives – straightforwardly asking adopters why they decided to adopt – were considered rather straightforward to compare. Although studies relying on self-stated data may have validity problems such as social desirability bias and recall problems, such biases could arguably be expected to affect the results in a similar direction across studies, thus allowing for comparison between them.

Furthermore, studies showing the following characteristics were excluded:

- Not measuring *motives* for adoption, but rather factual *perceptions.* For example, a survey item such as *"PV technology is good for the environment"* was not considered to measure motives, while the item *"Environmental concern was an important reason for me to adopt"* was.
- Relying on data obtained from non-adopters (e.g. regarding their *anticipated* adoption motives).
- Not limited to PV but including also other technologies (e.g. solar heating, micro wind), unless
  - o the PV-related results were reported separately and considered rigorous by themselves, or
  - o the non-PV data points were too few to possibly affect the relevant findings.
- Studies of 'involuntary adopters', i.e. adopters that had bought a house with an existing PV system.
- Studies using selection methods apparent to have a high risk of biasing the sample (one study was excluded for this reason, as it had recruited respondents through a website on climate change, which is arguably more likely visited by environmentally concerned people).

To identify relevant literature, searches were performed in Science Direct and Google Scholar using different combinations of terms to represent diffusion of innovations, adoption motives, and political views. For example, using the following string in Science Direct, the first 75 hits were considered for further investigation: (technology OR innovation OR PV OR renewable) AND (adopt OR adoption OR diffusion) AND (motive OR "political view"). Then, snowballing was used to identify further studies through the references of reviewed studies. This process was continued until saturation, i.e. until no further relevant studies could be identified through the references of the most recently read studies. In articles that reported results for different adopter cohorts separately depending on their time of adoption, the results for each cohort were treated as separate studies.

3.1.2. Assessment of market maturity

The earliness of the studied adopters was represented by the *market* *maturity* of the respective empirical setting. Market maturity was defined as the cumulatively installed distributed[2] PV capacity in watts per capita. The *empirical setting* was defined as the country or state of data collection around the time that the interviewed or surveyed adopters had adopted. For most settings, installation data were obtained from the International Energy Agency's (IEA) yearly National Survey Reports, published through its Photovoltaic Power Systems Programme [3]. For one national setting (UK 2011), there was no such report, and data[3] were in this case obtained from the UK feed-in tariff system [61].

Regarding the US, this is a large and diverse country, and all studies from the US were empirically limited to particular states. Thus, state-level data were used for the US settings. As comprehensive state-level data for residential, small-scale or distributed installations were not available, different sources were used. For California, data were obtained from the website of California Solar Statistics,[4] covering all rooftop installations participating in the California Solar Initiative rebate program. Data for Texas were obtained by subtracting utility-scale installations (obtained from the website of Berkeley Lab[5]) from the total installations (obtained through [62]). For Wisconsin, no figure for distributed installations could be obtained, and thus the total installed capacity [62] was used (utility-scale capacity in this northern state at such an early time was assumed small). Methodologically, the estimations for California and Wisconsin are cautious. As the Californian rebate programme may not include all rooftop PV installations, these figures likely underestimate total distributed installations to some extent, while the Wisconsin data likely overestimate the distributed PV capacity. Given the findings of these respective studies (see Table 1), these biases provide cautious estimates and do thus not harm the validity of the main findings.

In the reviewed studies, adoptions had typically occurred over an extended time period. One point in time could thus not represent all adopters of a given study. However, as PV adoption rates increase rapidly in most markets, the population of adopters in a given setting can be expected to consist mainly of relatively recent adopters. Indeed, in the studies that did provide detailed information on adoption times [46,47,50,55], adoptions tended to be concentrated to the times most recent before data collection. Thus, the point in time used to represent the respective empirical setting was chosen as follows:

- For studies not specifying adoption times, the end of the year preceding data collection was used.
- For studies providing an interval or a last time of adoptions without further specification, the end of the year preceding the last adoptions was used.
- For studies providing detailed information on adoption times, the end of the year with the largest number of adoptions was used.

3.1.3. Identification of motives

Next, the importance of different adoption motives was compared between the studies. In some studies, one single motive was found to be most important, while others found more than one motive to be most important. First, the motive(s) found most important in each study were identified. Second, the relative importance between environmental concern and economic gains was identified for each study. These two motives were used for pair-wise comparison because they appeared in all included studies, and because they represent fundamentally different driving forces (altruism and self-interest, respectively), thus lending themselves well to study shifts in adoption motives over time. Using this approach, differences in motives between earlier and later adopters could be identified.

3.2. Review results

Twelve research articles were found to fulfil the criteria and were hence included in the systematic review. Three of these articles contained two studied adopter cohorts each, that had adopted during different time intervals, and these papers were considered to consist of two separate studies each. The few reviewed studies that were found to address differences between earlier and later adopters are also accounted for in more detail in section 2.3. All studied settings – 15 in total – are found in Europe, the US, or Australia.

Table 1 displays the review's results. The table reveals that studies of later adopters (in more mature markets) tend to find economic gains to be the most important adoption motive, while studies of earlier adopters (in less mature markets) tend to find other motives, primarily environmental concern and technophilia, to be more important. The pattern is very clear – economic gains is the single most important motive in all but one of the settings with more than 5 W per capita. In contrast, environmental concern and technophilia dominate almost completely in settings with less than 5 W per capita.

Technophilia is expressed somewhat differently by different adopters, including a fascination for energy technologies and a wish to demonstrate the technology to others. Another reoccurring motive is energy independence, which is present among earlier as well as later adopters.

As seen in Table 1, market maturity differs dramatically between the studied settings. The results are thus quite insensitive to inaccuracies in the measurement of this parameter. The 'adopters' column indicates to which of Rogers' adopter categories the studied adopters are roughly estimated[6] to belong. As can be seen, the shift in adoption motives observed in this review – from environmental concern and technophilia to economic gains – occurs already among the innovators (it should be emphasised, though, that the methodology is not precise enough to estimate an exact point on the adopters' curve).

Given the above results, the following hypothesis is formulated to be tested in the empirical research in the next sections: *Earlier residential PV adopters are, to a larger degree than later adopters, driven by non-financial adoption motives such as environmental concern.*

4. Research design: empirical study of Swedish adopters

The empirical research tests the hypothesis that earlier residential PV adopters are, to a larger degree than later adopters, driven by environmental concern than later adopters, thus triangulating against the results of the systematic review performed in the previous section. It does so by employing municipal-level data on Swedish PV adopters over a nine-year period, using Green Party voting as a proxy for environmental concern. One regression model was built for each year of the period

[2] *Distributed* here refers to PV systems installed to provide electricity locally, typically as roof-mounted installations [3]. It is thus the function of the PV system, not its size, that qualifies it as distributed. This contrasts to *centralised* PV, which is installed to provide bulk power for wholesale purposes, typically as ground-mounted solar parks. Data on residential PV capacity specifically was not available for all contexts, and data for distributed PV was thus used to represent the market maturity for small-scale PV, although this data includes not only household installations but also distributed installations for businesses etc.

[3] This source, as opposed to the IEA's data, classified systems by size. It was assumed that PV systems <50 kW was equivalent to the IEA's 'distributed' class. This assumption was insensitive, as the bulk of UK PV systems were <10 kW.

[4] https://www.californiasolarstatistics.ca.gov/reports/monthly_stats, accessed 9 December 2019.

[5] https://emp.lbl.gov/capacity-and-generation-state, accessed 13 February 2020.

[6] These estimations assume that all households with a suitable home will eventually adopt PV, and that about 50% of the population lives in a suitable home.

Table 1
Results of the systematic literature review. The studies are presented in falling order of market maturity. There are two columns for results: one in which the most important motive out of economic gains and environmental concern is presented, and one in which the most important motive(s) overall are presented.

Empirical setting	Market maturity		Findings: most important adoption motives		Study
	Watts per capita	Adopters (Rogers' categories)	Economic gains versus environmental concern	Overall	
Australia 2014	152	Early majority	**Economic gains**	Economic gains	Sommerfeld et al. [56] (later cohort)
Australia 2011	49.6	Early adopters	**Economic gains**	Economic gains	Sommerfeld et al. [56] (earlier cohort)
Australia 2011	49.6		**Economic gains**	Economic gains	Simpson and Clifton [55]
California 2013	34.9		**Unclear**	Environmental concern; economic gains; energy independence	Rai et al. [47]
California 2012	28.2	Innovators	**Economic gains**	Economic gains	Sigrin et al. [57] (later cohort)
Sweden 2016	16.0		**Economic gains**	Economic gains	Palm [46] (later cohort)
California 2009	8.05		**Economic gains**	Economic gains	Sigrin et al. [57] (earlier cohort)
UK 2011	7.53		**Economic gains**	Economic gains; energy independence	Balcombe et al. [50]
Finland 2016	4.90		**Environmental concern**	Environmental concern; technophilia	Karjalainen and Ahvenniemi [36]
Netherlands 2003	2.23		**Unclear**	Environmental concern; economic gains	Jager [63]
Wisconsin 2010	1.53		**Environmental concern**	Environmental concern; technophilia	Schelly [37]
Sweden 2011	0.821		**Environmental concern**	Environmental concern; technophilia	Bergek and Mignon [51]
Texas 2010	0.815		**Unclear**	Environmental concern; economic gains; technophilia	Rai and McAndrews [64]
Sweden 2009	0.343		**Environmental concern**	Environmental concern; technophilia	Palm [46] (earlier cohort)
Austria 1993	0.0389		**Environmental concern**	Technophilia ("prove that PV works")	Haas et al. [38]

2009–2017, with year-specific data for PV adoptions and control variables. The regression coefficients were then used to calculate the effects of Green Party voting on PV adoptions in terms of percent growth of per capita adoptions. Thus, it could be investigated whether earlier adopters tended to live in municipalities with more environmentally concerned voters than later adopters. During the studied time period, the Swedish market for distributed PV grew from practically non-existing to quite established, see Fig. 1. This makes Sweden a good case for studying a shift from the earliest to somewhat later adopters.

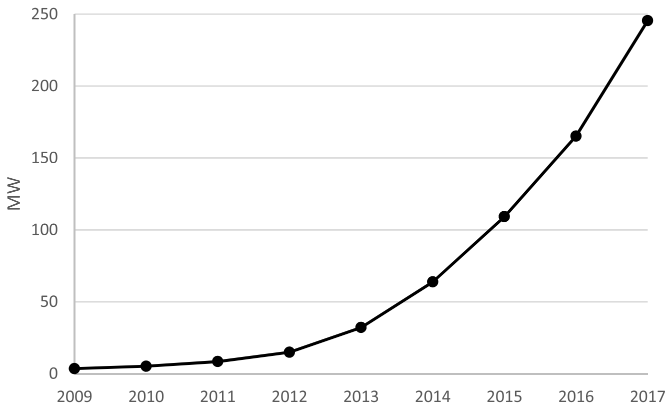

Fig. 1. Cumulatively installed distributed PV in Sweden during the studied period according to Lindahl et al. [65]. The figures include both residential and other distributed applications (e.g. PV installed on the rooftops of small businesses or multi-family buildings), but it is estimated that residential installations account for about half of this capacity in most years [65]. This graph is based on the time of installation, as opposed to the data used in the regressions which are based on the time of subsidy application.

4.1. *Independent variable*

The independent variable was the share of votes received by the Swedish Green Party in the national election of 2014. While support for political parties is often quite volatile depending on various short-term factors [66], ideological beliefs and issue preferences regarding political policies tend to be more stable over time [67,68]. Thus, it was decided to use Green Party support at one point in time (at around the middle of the studied time period) as a proxy for environmental concern for the whole time period.

Green Party support (particularly in the 2014 election) was considered a reasonable proxy for environmental concern for the following reasons. In general, Swedish voters traditionally perceive the Green Party as strongly associated with environmental issues [69]. Voters traditionally do not perceive the party as pronouncedly left- or right-wing, but rather as slightly left of centre [70]. Compared to most other parties, the Green Party has been perceived as quite narrowly focussed on one core issue [69], namely the environment. The party is also, as perceived by Swedish voters in general, the most trustworthy of all parties in the national parliament when it comes to promoting sound environmental policy [71]. A Google search by the author of this paper revealed that the Green Party did, in various voter opinion polls, consistently receive the by far highest trust regarding environmental issues until after the 2014 elections. A few years later, however, voters' trust regarding environmental policy was no longer as concentrated to one single party. (A likely explanation is that other parties had, by then, gotten more serious about adopting an environmental profile of their own, thus increasing the competition for environmentally concerned voters and challenging some core policy views of the Green Party, e.g. by proposing nuclear power buildout to reduce carbon emissions; the Green Party had until then faced little competition in the environmental domain.) In its election campaign of 2014, the Green Party focused strongly on, and (in the author's experience) mainly received media attention for, climate change mitigation, while other parties focused on other issues. In contrast, the overall political debate preceding the 2018 election was dominated by immigration issues in the wake of a so-called 'refugee crisis' bursting in 2015. As a consequence, in the 2018 campaign the Green Party – promoting a generous immigration policy – received much attention for its views on immigration, while its views on environmental issues received less attention than previously. Furthermore, the 2014 election results were chosen over the 2010 results because 2014 is closer to the middle of the studied time period. As a robustness check, the models were nevertheless run with data from all elections 2010–2018, providing similar results.

Data from the national election (rather than municipal or regional elections) were used because the focus, rhetoric, and perceived competence of local Green Party divisions might differ between one another. The national Green Party, on the other hand, upholds a rather uniform façade towards the whole country. Thus, national election results are more likely to measure the same thing in all municipalities.

A possible concern of the methodology could be reversed causation – that municipalities with a large share of Green Party voters could have implemented local policies (introduced by local Green Party divisions) supporting PV, thus affecting adoptions. However, the Swedish PV policy framework has been quite uniform throughout the country; for example, no sub-national subsidies have existed, and permits for grid-connection have been regulated on the national level [33]. Although some variation in building permit processes have existed, national regulations have set limits to how much municipalities can deviate on this issue, and building permit processes have typically not hindered Swedish PV installations [72].

4.2. *Dependent variable*

The dependent variable of each regression model was the per capita number of adoptions of residential PV systems occurring during the year in question. Data on PV adoptions were obtained from a dataset, provided by the Swedish Energy Agency, for an investment subsidy scheme that has been available for Swedish PV adopters since 2009. The number of approved subsidy applications was used to estimate the number of adoptions. During the studied time period the subsidy has, as a response to reduced PV system prices, been stepwise reduced from 60% to 20% of the PV system's price. At such high reimbursement rates, and with limited (although not insignificant) effort required to apply, few homeowners could be expected to adopt PV without applying for the subsidy. Interviews with installers have also revealed that practically all adopters apply for the subsidy [72]. Thus, the subsidy data can be expected to reflect the actual number of adoptions quite well. Only applications that were followed by an actual installation were used in the analysis (around 70% of all submitted applications have typically been followed by installation).

The point in time when the adopter submitted the subsidy application was considered the time of adoption. The process of adopting PV takes time, and it is not obvious which event in this process should be considered the adoption. Data on the time of contract signing or physical installation are not available, nor would they necessarily be the most purposeful measures of the adoption time. Asking people when they decided to adopt is neither known to be a reliable option, as adopters tend to be unable to recall this information reliably [2, pp. 126–128].

Even though the subsidy application takes place before the actual installation, the time of application is arguably purposeful for approximating the time of adoption *decision*, which is what is relevant for the present study. Due to persisting uncertainties regarding how long the funding for the subsidy would last [72], prospective adopters have been incentivised to apply early to secure being granted the subsidy. To complete the application, the applicant must however make some effort in planning and information gathering, preventing people from applying unless they have a real intention to adopt (as stated, most applications have been followed by adoption). Thus, as there are incentives not to wait unnecessarily long and not to apply unless there is a real intention to adopt, the time of application is expected to provide a reasonable estimate of the time of adoption decision.

4.3. *Control variables*

A set of six control variables was used, see Table 2. These were based on previous research on factors affecting PV adoption rates (see section 2.2), as well as on the experiences and intuition of the author.

Table 2
Control variables and rationales for using them.

Variable	Unit	Rationale
Population density *(Registered inhabitants per area unit in 2016)*	persons*hectare^{-1}	Population density is a common control variable in the social sciences. It may correlate with socioeconomic factors, and might capture factors related to for example mindset, access to installers, or local peer effects.
Age *(Mean age of inhabitants in 2016)*	years	Preferences may differ depending on age.
GHI *(Global horizontal irradiance, i.e. 'the amount of sunshine')*	MWh*m^{-2}*year^{-1}	More solar insolation increases the economic gains in adopting PV.
Detached homes *(Number of detached homes* per capita *in 2016)*	detached homes*person^{-1}	Living in a detached home is typically a precondition for adopting PV.
Home price increase *(Mean price increase of detached homes during 2007-2017)*	percent (for the full ten-year period)	Increasing home prices affect homeowners' total wealth, which could affect their propensity to adopt PV.
Income *(Mean income from salaries and pensions of people aged 20 and above in 2016)*	SEK 10 000*person^{-1}*year^{-1} (~USD 1000*person^{-1}*year^{-1})	Income may affect people's will or ability adopt PV.

5. Empirical results

The results of the yearly models are shown in Fig. 2. As can be seen, the relationship between PV adoption rates and environmental concern (as estimated by Green Party voting in the national election of 2014) weakens over time. While an increase of one percentage point in Green Party support is associated with an increase in local PV adoption rates of around 30% at the beginning of the period, the corresponding figure has dropped to around 14% by the end of the period. This lends support to the hypothesis that earlier PV adopters are more driven by environmental concern than later adopters. The full results of the regressions are shown in the Appendix, Table A1.

With the exception of 2015, when the importance of environmental concern for adoption rates temporarily increases, the trend of a weakening relationship between these variables is rather consistent. A trendline (fitted through linear regression) reveals a statistically significant decreasing trend over the period. As seen in Table 3, the temporarily stronger importance of environmental concern in 2015 coincides with a temporary decrease in adoptions. This dip is likely due to a temporary dip in the perceived possibilities of receiving the subsidy. Around 2015, the subsidy scheme experienced a lack of funding and, as a result, waiting times and uncertainties regarding application approval increased dramatically [73]. This appears – as suggested by the results – to have discouraged adoption mainly among people less driven by environmental concern.

A robustness check, using data from the average of the Green Party's results of all national elections 2010–2018, provided similar results. Using this data, the trendline (corresponding to that of Fig. 2) had a slope of −0.017 and a p-value of 0.071.

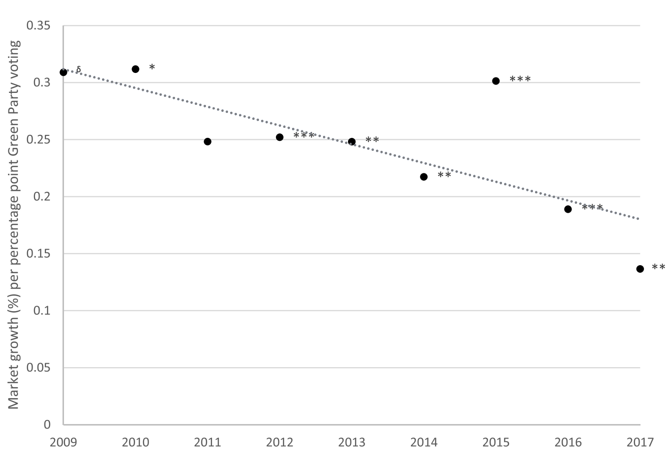

Fig. 2. Each dot represents the estimated PV market growth, in percent, per percentage point increase in Green Party support. The specification of statistical significance next to each dot refers to the regression coefficient of the independent variable. The trendline has a slope of −0.016, an R^2 of 0.59, and a p-value of 0.016.

The expected economic gains of PV adoption have increased during the studied period, mainly due to decreasing prices of PV systems. In Fig. 3, the estimated payback times[7] (i.e., time required for the PV system to pay for itself through electricity generation) are shown for PV systems adopted in Sweden at different times. The improved economic gains (shortened payback times) of PV adoption could potentially explain the decreasing importance of environmental concern; it should be no surprise if improved economic returns attract other adopters than those primarily driven by environmental concern. However, by the end of the period, payback times almost completely cease to decrease. Yet, the trend of decreasing importance of environmental concern continues, suggesting that the earliness of adoption in itself (disregarding economic gains) plays at least some part in explaining the decreasing importance of environmental concern over time.

The adopters studied could, using Rogers' terminology, be categorised as innovators. Summing up all adoptions in Table 3, and comparing these to the total potential Swedish adopter base,[8] it is roughly estimated that somewhere around 1% of all potential residential PV adopters had adopted PV by the end of 2017 (innovators are, according to Rogers, the first 2.5% to adopt).

Table 3
Yearly number of residential PV adoptions (the time of adoption is here defined as the time of subsidy application).

Year	Adoptions
2009	130
2010	200
2011	321
2012	673
2013	1234
2014	1227
2015	860
2016	1598
2017	2564

[7] Payback times were estimated using concurrent subsidies and electricity prices; 50% self-consumption; and no cost of capital (which, in the author's experience, is how Swedish installers and homeowners tend to present and think of the investment). Although these assumptions may substantially affect the calculated values, the shape of the curve (decreasing, flattening towards the end) remains similar when the assumptions are altered.

[8] Based on figures on the Swedish housing stock provided by Statistics Sweden, the number of homes with suitable rooftops in the country can be roughly estimated to 1 M, thus indicating the upper limit of the number of adoptions.

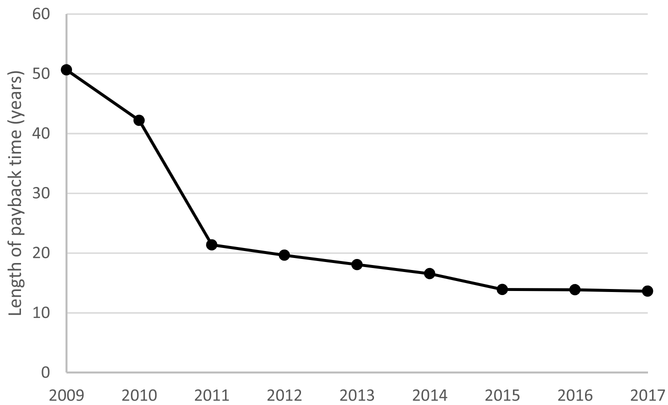

Fig. 3. Estimated payback time for a PV system purchased at different points in time. The decreasing trend is mainly due to decreasing costs of PV modules on the global market. The estimations disregard from temporary uncertainties in the subsidy scheme (applications submitted in 2015 were eventually approved, although this was not clear at that time).

6. Conclusion and discussion

This paper provides evidence that earlier adopters of residential PV systems are to a large extent driven by other adoption motives than later adopters. First and foremost, it is found that non-financial adoption motives, such as environmental concern, are more important among the earliest adopters than among later adopters. The research reveals that already among the very earliest adopters (the innovators, cf. Rogers [2]), the importance of environmental concern as an adoption motive decreases rapidly as the market matures. Later adopters (including Rogers' so-called early adopters, and even late innovators), on the other hand, are driven primarily by economic gains.

This finding is supported by both a systematic literature review of adoption motives in relation to market maturity, and an empirical study of Swedish adopters. The systematic review and the empirical study rely on fundamentally different methodologies and data; while the reviewed literature uses self-stated data, the empirical study uses revealed political preferences that are arguably intimately connected to true environmental concern. Yet, both the review and the empirical research point in the same direction, thus strengthening the validity of this finding through triangulation [cf.74]. A limitation of the paper is, however, that it is empirically limited to very early adopters. The 'later' adopters studied here are, in fact, rather early to adopt from a broader perspective, and they may not necessarily represent even later adopters.

The systematic literature review reveals that the earliest PV adopters are not only driven by environmental concern, but to a similar extent by other motives, mainly related to technophilia. Among later adopters, on the other hand, economic gains tend to dominate over all other motives. It is, thus, likely that the empirical results of the present paper reflect a shift from a broader set of non-financial motives towards economic ones. Due to data availability, the present empirical research was limited to environmental concern. However, people with high levels of environmental concern are known to have more altruistic and self-transcendent value orientations [e.g.75,76]. Thus, variables for technophilia, novelty seeking, and altruism may have shown a declining trend as well if applied to the same data set.

The findings are in line with previous research on differences between earlier and later PV adopters, while also making distinct contributions. The contribution of the systematic literature review is to reveal that dynamics that have previously been observed in a couple of settings [46,57] occur more generally throughout various geographical contexts. The contribution of the empirical research is mainly that of triangulation, employing methodology not previously applied to study differences between earlier and later PV adopters. This is important because previous studies rely on self-stated data, which could be problematic from a validity perspective due to e.g. social desirability bias (earlier adopters could, for example, be more prone to report socially desirable answers in an interview situation – an explanation that seems less likely given the present empirical results).

Given this paper's findings, research on PV diffusion should arguably pay more attention to market maturity. There are plenty of studies investigating factors affecting PV adoption rates in different contexts with different levels of PV penetration (see section 2.2). However, most of them provide snapshots without further analysis of – or even reflection upon – how the market maturity of their studied settings could affect their results. The present study demonstrates that the importance of certain variables can change dramatically over relatively short timespans as a market matures – something that may be true for other variables as well. Thus, for existing studies of later adopters some results should be expected to differ from studies of earlier adopters. Failure to take market maturity into account could thus potentially (at least partly) explain some inconsistencies in the previous research. Most notably, the previous research is highly inconsistent on the relative importance of different adoption motives when not taking market maturity into account (which most studies fail to do). However, the systematic review of the present paper demonstrates that, once taking market maturity into account, the results of previous studies are actually quite consistent. Arguably, future studies on PV diffusion should assess the market maturity of their studied settings and discuss their results in relation to it, taking the results of the present paper and other relevant studies (see section 2.3) into account. Future studies could also differentiate between adopter cohorts depending of their time of adoption.

As stated in section 2.1, previous research on early adoption of different innovations has found earlier adopters to be more oriented towards profits and savings than later adopters. Against this background, the findings of the review might seem surprising. However, it is important to keep in mind that all adopters studied in the present paper – also the 'later' ones – are relatively early to adopt. Hence, the findings are not necessarily at odds with previous research on this point, as even later adopters may prove to be driven by other motives. This is a matter for future research to be carried out as PV markets mature around the world. It is also possible that earlier PV adopters are more profits and savings oriented in their general consumption behaviour, although this orientation is overridden by other motives in their PV adoption decision.

A limitation of the present research is that the causes of the observed trends remain unclear: is the shift in adoption motives purely a consequence of the order in which people adopt, or of other factors that tend to change along with PV market growth? Sorting this out is difficult, as economic, technical, and institutional conditions for PV adoption tend to improve in parallel with growth in installed capacity [e.g. 72]. Arguably, it would not be surprising if improved economic returns from PV adoption caused people to adopt for economic reasons, regardless of how many have adopted before them. Indeed, the empirical results of the present study indicate that when the economic gains of adopting PV were suddenly impaired, the importance of environmental concern increased again. As discussed in section 2.3, the results of De Groote et al. [22] point in a similar direction. This suggests that it is not only the earliness of adoption per se that causes the observed trend. There is, however, also some evidence that the order of adoption in itself contributes to the trend. First, the empirical research revealed that the relationship between environmental concern and PV adoption rates continued to weaken even when payback times ceased to decrease. Second, the reviewed literature revealed that even with payback times shorter than 10 years (implying a good economic case for PV adoption), environmental concern remained as important a motive as economic gains among innovators [63,64].[9] In contrast, the later adopters studied by Palm [46] adopted for primarily economic reasons despite facing substantially longer (albeit still financially beneficial) payback times (see Table 1 and Fig. 3). This suggests – albeit the evidence is admittedly limited on this point – that later adopters tend to be less driven by environmental concern than earlier adopters *even when not facing better economic conditions from adopting PV*. Future research could pursue further evidence on this matter.

Another limitation is that the input values for the estimation of the trendline of Fig. 2 are laden with some uncertainty as the values on the vertical axis are themselves estimated through regression. Such a two-step process (using regression coefficients to construct inputs to another regression) may result in reduced internal validity as errors in the first analysis may propagate to the second one [cf.77]. This implies that the p-value calculated for the trendline is uncertain. On the other hand, the hypothesis tested is well underpinned through the systematic literature review, strengthening the overall internal validity of the paper's main result.

Another limitation is that the research is based exclusively on adopters in Europe, the US, and Australia. Future research could investigate adopters in other cultural contexts.

Another matter for further research is to investigate whether the tendency of the earliest PV adopters to be driven by environmental concern reflects some more general characteristic of innovators or early adopters. For example, these adopters may more often be driven by altruistic or idealistic motives (however perceived) across different technologies.

The present results may be useful to different actors. First, any actor interested in increasing PV adoption rates through information provision could find them useful. Research has shown that publicly organised information campaigns can substantially boost PV adoption [29,30]. Given the present results, such campaigns can arguably be adapted to appeal to the most likely adopters by e.g. focusing on environmental issues and the thrill of a new technology in the most immature markets, while focusing on economic aspects (at least if there is an economic case for PV adoption) and other practical matters in more mature markets. For similar reasons, private actors in the PV business may find the results helpful in their advertising. This said, in some cases there may be other contextual aspects that are more important, such as local discourses on climate change or a sudden introduction of generous subsidies or other policies. Another set of actors that may find the results useful are researchers forecasting PV diffusion; understanding what drives PV diffusion at different stages of market maturity may help them build more accurate models.

CRediT authorship contribution statement

A. Palm: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A.1

Regression results for each year of the studied time period. Values are rounded to three significant figures. The coefficients in this table are presented as absolute values, and thus tend to increase over time due to the growing PV market. The decreasing importance of Green Party voting over time is observed when recalculating the coefficients to relative (percent) values (see Fig. 2).

Variable	Coefficient		Standard Error	t Stat	Lower 95%	Upper 95%
2009						
Green Party support	0.0430	δ	0.0241	1.79	−0.00435	0.0904
Population density	0.00603		0.00755	0.798	−0.00884	0.0209
Income	−0.00871		0.0132	−0.658	−0.0348	0.0173
GHI	0.000715	*	0.000350	2.04	0.0000261	0.00140
Home price increase	0.000753		0.00162	0.464	−0.00244	0.00394
Age	0.00547		0.0186	0.294	−0.0311	0.042
Detached homes	2.50	***	0.648	3.86	1.23	3.78
2010						
Green Party support	0.0662	*	0.0258	2.56	0.0153	0.117
Population density	−0.00466		0.00788	−0.591	−0.0202	0.0109
Income	0.00253		0.0135	0.187	−0.0241	0.0292
GHI	0.000870	*	0.000373	2.33	0.000135	0.00160
Home price increase	−0.000972		0.00174	−0.558	−0.00440	0.00246
Age	0.0359	δ	0.0197	1.82	−0.00283	0.0746
Detached homes	1.71	*	0.697	2.45	0.336	3.08
2011						
Green Party support	0.0840		0.0546	1.54	−0.0236	0.192
Population density	0.00514		0.0162	0.316	−0.0268	0.0371
Income	−0.0118		0.0276	−0.429	−0.0662	0.0425

(*continued on next page*)

[9] Only three of the papers included in the systematic literature review reported payback times, all of them studying very early adopters (innovators). Jager [63] stated that his studied adopters had participated in a subsidy program reducing payback times to about three years. Most adopters studied by Rai and McAndrews [64] had reported payback times of 7–10 years, while most adopters studied by Karjalainen and Ahvenniemi [36] had reported payback times of 15–25 years. As PV systems typically last for decades, payback times of <10 years clearly offer a beneficial investment.

Table A.1 (*continued*)

Variable	Coefficient		Standard Error	t Stat	Lower 95%	Upper 95%
GHI	0.00207	**	0.000791	2.62	0.000516	0.00363
Home price increase	0.00315		0.00370	0.851	−0.00413	0.0104
Age	0.00621		0.0414	0.150	−0.0753	0.0877
Detached homes	5.49	***	1.49	3.69	2.56	8.42
2012						
Green Party support	0.177	***	0.0530	3.35	0.0732	0.282
Population density	−0.0109		0.0153	−0.716	−0.0411	0.0192
Income	−0.0126		0.0263	−0.478	−0.0644	0.0393
GHI	0.00200	**	0.000763	2.62	0.000498	0.00350
Home price increase	0.00791	*	0.00359	2.20	0.000841	0.0150
Age	0.0124		0.0402	0.309	−0.0667	0.0916
Detached homes	6.93	***	1.45	4.77	4.07	9.79
2013						
Green Party support	0.317	**	0.101	3.15	0.119	0.516
Population density	−0.00527		0.0284	−0.186	−0.0611	0.0506
Income	−0.0855	δ	0.0489	−1.75	−0.182	0.0108
GHI	0.00291	*	0.00146	1.99	0.0000367	0.00578
Home price increase	0.0133	δ	0.00689	1.94	−0.000226	0.0269
Age	−0.00227		0.0770	−0.0294	−0.154	0.149
Detached homes	14.5	***	2.79	5.20	9.01	20.0
2014						
Green Party support	0.274	**	0.0946	2.89	0.0872	0.460
Population density	−0.00664		0.0261	−0.254	−0.0581	0.0448
Income	−0.0747	δ	0.0441	−1.69	−0.162	0.0121
GHI	0.000303		0.00137	0.222	−0.00239	0.00300
Home price increase	−0.00439		0.00647	−0.679	−0.0171	0.00835
Age	−0.0419		0.0728	−0.576	−0.185	0.101
Detached homes	11.3	***	2.65	4.24	6.04	16.5
2015						
Green Party support	0.263	***	0.0616	4.27	0.142	0.384
Population density	−0.00463		0.0166	−0.279	−0.0373	0.0280
Income	−0.0598	*	0.0276	−2.17	−0.114	−0.00548
GHI	0.00186	*	0.000894	2.08	0.0000998	0.00362
Home price increase	0.00649		0.00422	1.54	−0.00182	0.0148
Age	−0.0197		0.0471	−0.419	−0.112	0.0730
Detached homes	9.96	***	1.74	5.71	6.53	13.4
2016						
Green Party support	0.302	***	0.0791	3.82	0.146	0.458
Population density	−0.0140		0.0210	−0.668	−0.0553	0.0273
Income	−0.0743	*	0.0347	−2.14	−0.143	−0.00609
GHI	0.00250	*	0.00116	2.15	0.000211	0.00479
Home price increase	0.00405		0.00546	0.742	−0.00670	0.0148
Age	−0.0373		0.0614	−0.608	−0.158	0.0836
Detached homes	11.4	***	2.24	5.10	7.02	15.8
2017						
Green Party support	0.346	**	0.120	2.87	0.109	0.583
Population density	−0.000533		0.0312	−0.0171	−0.0619	0.0609
Income	−0.127	*	0.0519	−2.44	−0.229	−0.0244
GHI	0.0122	***	0.00178	6.84	0.00866	0.0156
Home price increase	0.0232	**	0.00831	2.79	0.00682	0.0395
Age	0.0894		0.0921	0.971	−0.0918	0.271
Detached homes	22.3	***	3.42	6.52	15.6	29.1

$^{\delta}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

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